Properties of Earth's Interior

_____ - _____

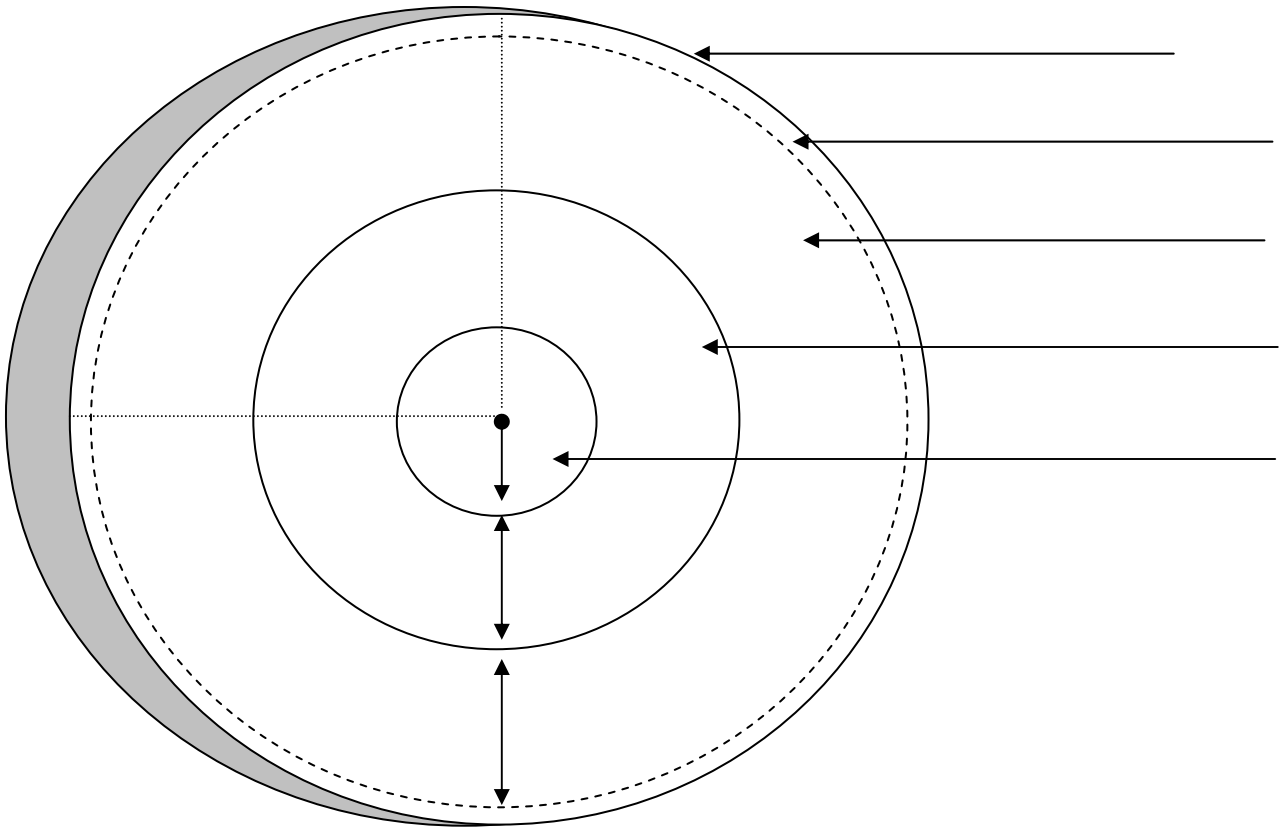
_____ - _____

_____ - _____

_____ - _____

_____ - _____

_____ - _____



Earth's interior _____

ESRT page _____

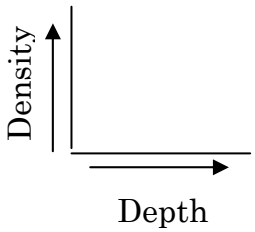
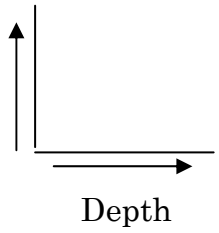
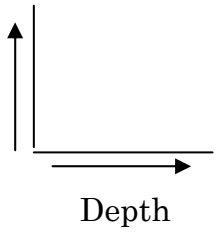
Determine the following:	Density	Composition / Rock Type
Continental Crust	g/cm^3	
Oceanic Crust	g/cm^3	

MOHO - _____

_____

Layer	Density Range (g/cm^3)	Pressure Range (millions of atmospheres)	Temperature Range (°C)
Mantle		-	-
Outer Core		-	-
Inner Core		-	-

State and **draw** the following relationships:

Depth vs. Density	Depth vs. Pressure	Depth vs. Temperature
As depth increases, density	As	As
		

Determine the following by referring to the Earth Science Reference Tables page 10, "Inferred Properties of Earth's Interior"

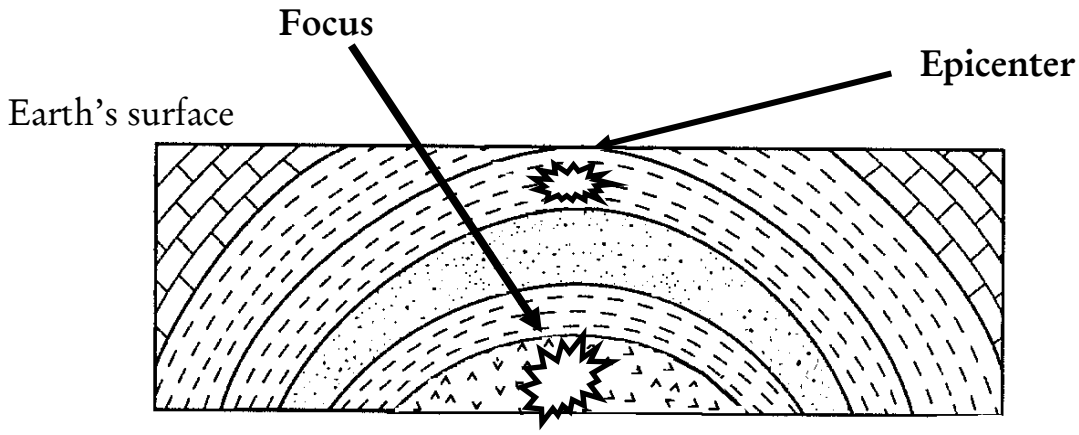
1. What two layers make up the lithosphere? _____
2. Name the two elements that compose the inner core. _____
3. Which layer is a liquid? _____ Explain how you can tell by looking at the chart. _____

   _____
4. What is the pressure at the stiffer mantle and outer core boundary? _____ mil atm.
5. What is the temperature at a depth of 3000 km? _____ °C
6. What is the temperature at a depth of 500 km? _____ °C

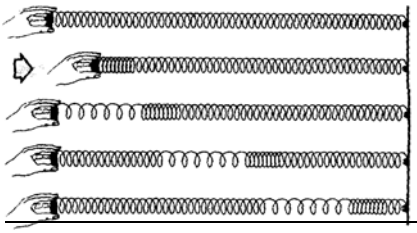
7. What is the pressure at a depth of 5000 km? _____ mil of atm
8. What is the temperature at a depth of 1000 km? _____ °C
9. What is the pressure at a depth of 3500 km? _____ mil of atm
10. What is the temperature at a depth of 5000 km? _____ °C
11. What is the pressure at a depth of 1000 km? _____ mil of atm
12. What is the temperature at a depth of 4500 km? _____ °C
13. Name the layer where the temperature is 4000 ºC _____
14. Name the layer where the temperature is 6000 ºC _____
15. Name the layer where the pressure is 3.5 million atmospheres _____
16. Name the layer where the pressure is 2.4 million atmospheres _____
17. Name of the mountains next to the trench on the diagram _____

Earthquakes

1. What is an earthquake? _____
2. Possible causes? _____
3. Damages _____
4. Focus _____
5. Epicenter _____
6. Most earthquakes and volcanoes occur at or near _____



Two Main Types of Earthquake Waves

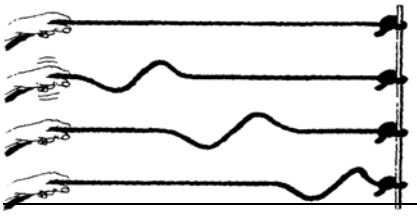


P – waves:

(1)

(2)

(3)



S – waves:

(1)

(2)

(3)

Measuring an Earthquake:

Richter scale - _____

Mercalli Scale - _____

Richter number	Increase in Magnitude
1	1
2	10
3	100
4	1,000
5	10,000
6	100,000
7	1,000,000
8	10,000,000
9	100,000,000

Reading the Earthquake P-wave and S-wave Travel Time Chart, ESRT page 11

1. How long does it take a P-wave to travel 2,000 km? _____ min _____ sec
2. How long does it take an S-wave to travel 2,000 km? _____ min _____ sec
3. How far can an S-wave travel in 11 minutes? _____ km
4. How far can a P-wave travel in 11 minutes? _____ km
5. How long does it take a P-wave to travel 6,000 km? _____ min _____ sec
6. How far can an S-wave travel in 9 minutes 40 sec? _____ km

State how long it takes for the P-wave and the S-wave to travel the distances listed below:

Distance	P – Wave Travel Time		S – Wave Travel Time	
7,000 km	min	sec	min	sec
3,900 km	min	sec	min	sec
2,000 km	min	sec	min	sec
1,600 km	min	sec	min	sec
2,100 km	min	sec	min	sec
8,200 km	min	sec	min	sec
3,500 km	min	sec	min	sec

State how far a P-wave and an S-wave can travel in each given time below:

Given Time		P – Wave Distance	S – Wave Distance
4 min	20 sec	km	km
12 min	00 sec	km	km
6 min	20 sec	km	km
8 min	30 sec	km	km
10 min	20 sec	km	km
5 min	50 sec	km	km
9 min	40 sec	km	km

Determining the arrival time differences between P-waves and S-waves using the chart:

1. _____

_____

2. _____

_____

3. _____

_____

4. _____

_____

_____

Determine the difference in arrival time for each of the following:

8,000 km	min	sec
5,200 km	min	sec
9,600 km	min	sec
400 km	min	sec
6,400 km	min	sec

3,200 km	min	sec
1,800 km	min	sec
4,400 km	min	sec
2,100 km	min	sec
7,200 km	min	sec

Determining distance of an earthquake by using differences in P-wave and S-wave arrival times.

1. _____

_____

2. _____

_____

3. _____

_____

_____

_____

4. _____

_____

How far away is the epicenter if the difference in arrival time is . . .

3	min	20	sec	km	5	min	40	sec	km
6	min	00	sec	km	2	min	30	sec	km
8	min	40	sec	km	10	min	00	sec	km
10	min	20	sec	km	3	min	00	sec	km
5	min	00	sec	km	3	min	40	sec	km
1	min	40	sec	km	6	min	40	sec	km

Questions:

5. A seismic recording station recorded the difference between the arrival times of a P and S-wave to be 6 min 40 sec. How far away is the epicenter from this seismic recording station?

_____ km

6. A seismic recording station recorded the difference between the arrival times of a P and S-wave to be 9 min 20 sec. How far away is the epicenter from this seismic recording station?

_____ km

7. A seismic recording station recorded the difference between the arrival times of a P and S-wave to be 2 min 40 sec. How far away is the epicenter from this seismic recording station?

_____ km

Determining the difference in P-wave and S-wave arrival times.

- Subtract the P-wave arrival time from the S-wave arrival time.

Example 1: A seismic recording station recorded an earthquakes P-wave at 1:00:20. The S-wave arrived shortly after 1:04:40. How far away is the epicenter from this seismic recording station?

S wave arrival time _____

P wave arrival time _____

Difference _____

Using the procedure on page 78 determine the distance to the epicenter _____ km

Example 2: A seismic recording station recorded an earthquake's P-wave at 10:08:00. The S-wave arrived shortly after 10:15:40. How far away is the epicenter from this seismic recording station?

S wave arrival time _____

P wave arrival time _____

Difference _____

Using the procedure on page 78 determine the distance to the epicenter _____ km

- If the S-wave arrival time minutes or seconds are less than the P-waves, you will need to borrow "time".
- REMEMBER: there are 60 seconds in a minute and 60 minutes in an hour.

Example 1: A seismic recording station recorded an earthquakes P-wave at 3:59:40. The S-wave arrived shortly after 4:05:40. How far away is the epicenter from this seismic recording station?

S wave arrival time _____

P wave arrival time _____

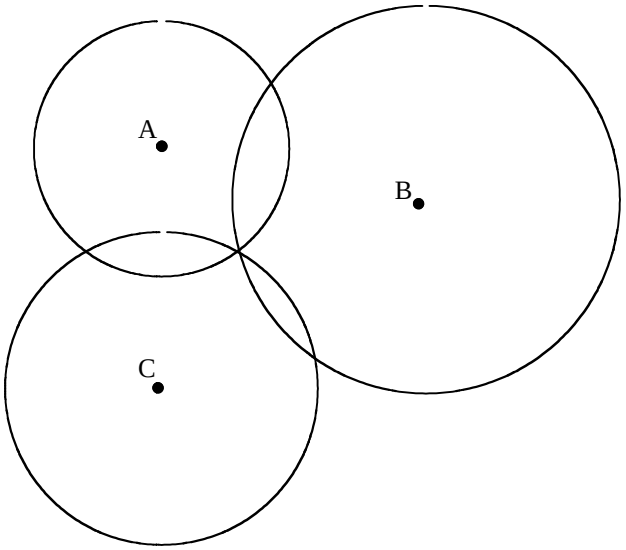
Difference _____

Using the procedure on page 78 determine the distance to the epicenter _____ km

Locating the Epicenter

A minimum of _____ seismic stations are needed to locate an earthquake epicenter.

- One seismic station gives you _____ only, and _____
- Two stations may give you ____ possible locations where the two circles intersect
- When _____ stations are used, the epicenter is where they all _____



a. Which seismic station is closest to the epicenter? _____
How can you tell by the diagram?

_____

b. Which seismic station is farthest away from the epicenter? _____
How can you tell by the diagram?

_____

c. Describe where the epicenter is.

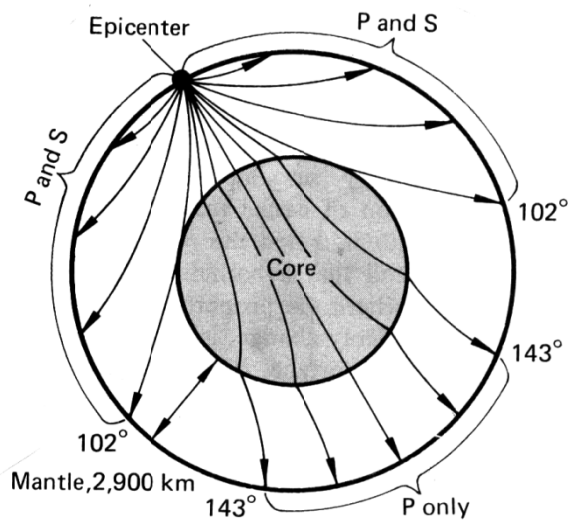
_____

_____

d. Place an "X" at the epicenter.

Shadow Zone Diagram

As P-waves and S-waves pass through different layers within Earth's interior they are _____ due to differences in _____

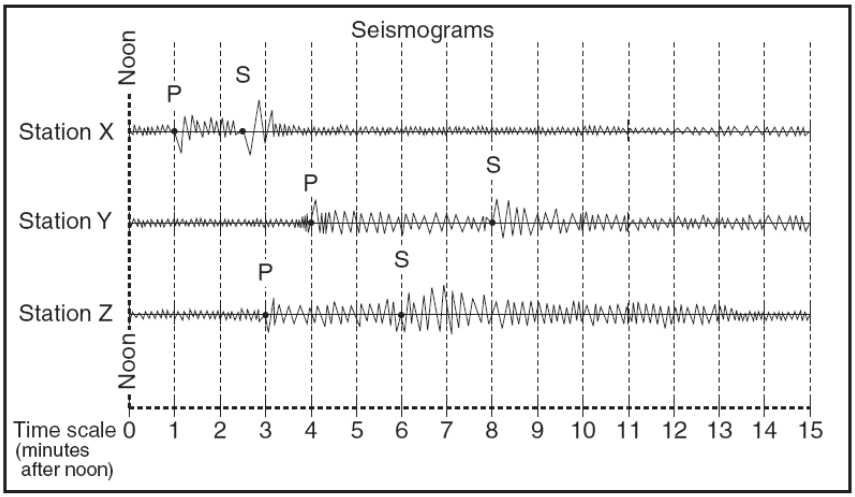


Some areas on Earth's surface only receive P-waves, because S-waves can only travel through _____ and the _____ is liquid.

Other sections on Earth's surface receive no earthquake waves because of the way the waves _____ within the Earth.

These areas are known as the _____

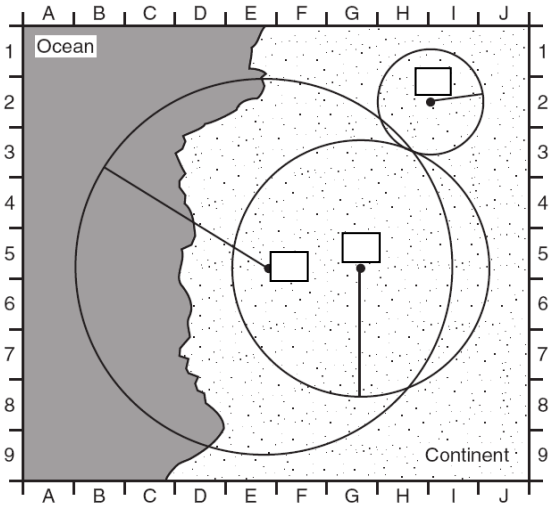
Reading Seismograms: The diagram shows three seismograms of the same earthquake recorded at three different seismic stations, *X*, *Y*, and *Z*. Using the information on the diagram, fill in the table below. *NOTE: Instead of subtracting – just COUNT.*



	Station X		Station Y		Station Z	
Difference in arrival time	min	sec	min	sec	min	sec
Distance to the epicenter	km		km		km	
P-wave travel time	min	sec	min	sec	min	sec
S-wave travel time	min	sec	min	sec	min	sec

The distances from each seismic station to the earthquake epicenter have been drawn on the map to the right.

A coordinate system has been placed on the map to describe locations. The map scale has not been included.



1. In the three boxes provided, label the location of each seismograph station using the corresponding letters, X, Y and Z.

2. Which location is closest to the epicenter?

   (1) E-5 (2) G-1 (3) H-3 (4) H-8

   Explain your reasoning. _____

   _____

3. State two ways in which you can determine which seismograph station was the closest to an epicenter if you were not provided with a time scale on the bottom of the graph.

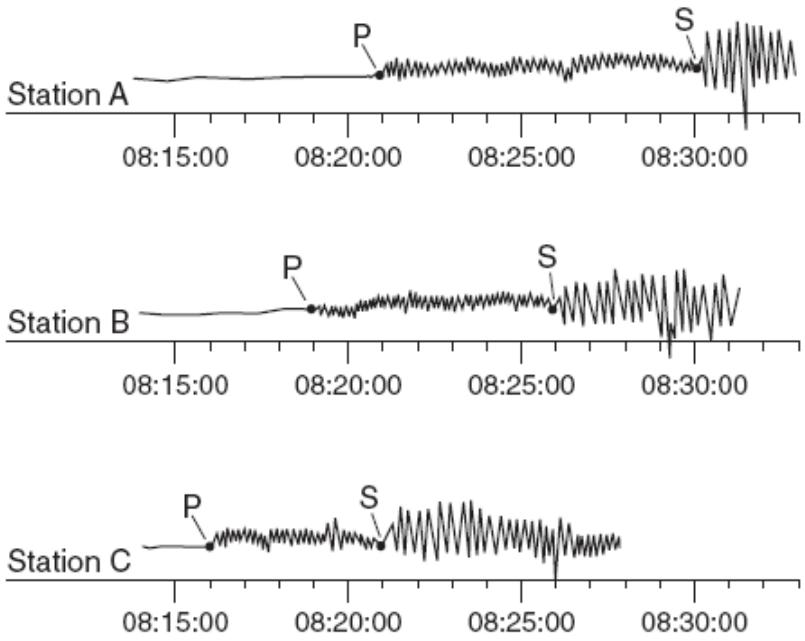
   _____

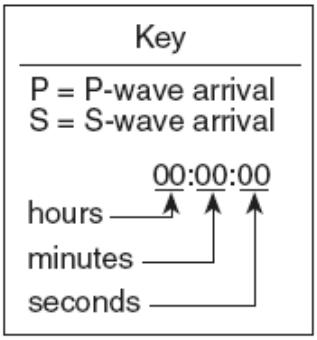
   _____

   _____

4. The diagram below represents three seismograms showing the same earthquake as it was recorded at three different seismic stations, A, B, and C.
   (a) How much time does each mark represent on the seismograms? _____
   (b) Draw arrows down from the P-wave and S-wave points to show arrival times.
   (c) What is the difference in arrival times for each station below?

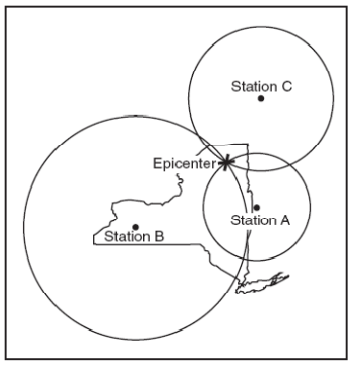
   Station A ____ min ____ sec
   Station B ____ min ____ sec
   Station C ____ min ____ sec





5. Which statement correctly describes the distance between the earthquake epicenter and the seismic stations above?
   (1) A is closest to the epicenter, and C is farthest from the epicenter.
   (2) B is closest to the epicenter, and C is farthest from the epicenter.
   (3) C is closest to the epicenter, and A is farthest from the epicenter.
   (4) A is closest to the epicenter, and B is farthest from the epicenter.

6. The map to the right shows the location of an earthquake epicenter in New York State. Seismic stations A, B, and C received the data used to locate the earthquake epicenter.



   The seismogram recorded at station A would show the
   (1) arrival of P-waves, only
   (2) earliest arrival time of P-waves
   (3) arrival of S-waves before the arrival of P-waves
   (4) greatest difference in the arrival times of P-waves and S-waves

Review Questions:

1. The place within the Earth where an earthquake originates is called the _____
2. The place on the surface of the Earth directly above the point at which an earthquake originates is called the _____
3. According to the Richter scale, an earthquake that measures 4 releases how many times more energy than a quake that measures 3? _____
4. Which type of waves will not travel through liquids? _____
6. The _____ scale is used to measure the damage caused by an earthquake.
7. Name the type of earthquake wave that travels the fastest _____
8. There are certain places on earth that can not record any earthquake waves. This is known as the _____
9.. How far will a P wave travel in 7 minutes and 20 seconds? _____ km
10. How far will an S wave travel in 5 minutes? _____ km
11. An earthquake epicenter occurred 6000 km from an observer. What is the difference in arrival time between the arrival of the P-wave and S-wave? _____ min _____ sec
12. Explain why there is a minimum of three seismic stations needed when determining the location of an earthquake epicenter. _____

_____

_____

_____

13. What evidence do scientists have that indicates Earth has a liquid outer core?

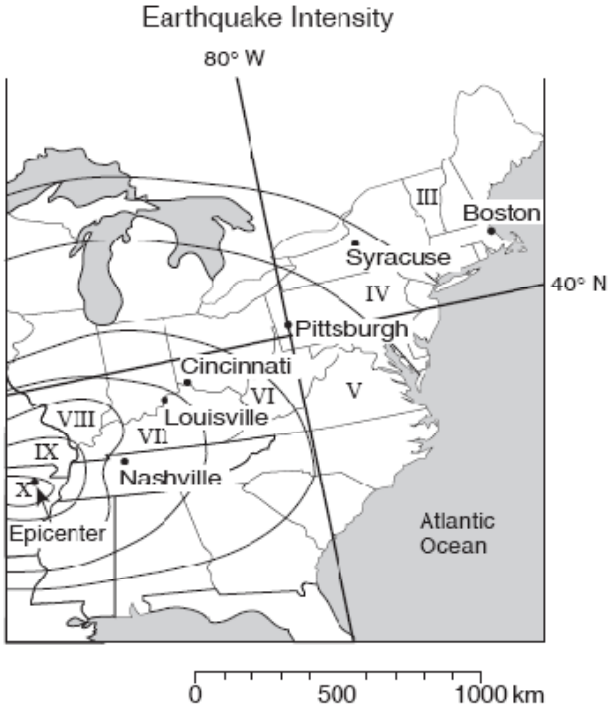
_____

14. Fill in the table below, which compares P-wave and S-wave characteristics.

	P- wave	S- wave
Travel time		
Travel direction		
Can travel through		

15. Which statement best describes the relationship between the travel rates and travel times of earthquake P-waves and S-waves from the focus of an earthquake to a seismograph station?
    (1) P-waves travel at a slower rate and take less time.
    (2) P-waves travel at a faster rate and take less time.
    (3) S-waves travel at a faster rate and take less time.
    (4) S-waves travel at a slower rate and take less time.

Base your answers to questions 1 through 5 on the *Earth Science Reference Tables*, the map and table of the Modified Mercalli Scale below, and your knowledge of Earth science. The map shows the intensities of the earthquake that occurred slightly southwest of New Madrid, Missouri, on December 16, 1811. The numbered areas on the map were determined from the Modified Mercalli Scale according to the observed effects of the earthquake.



Modified Mercalli Scale

Intensity	Observed Effects
I	Felt by only a few people under very special circumstances
II	Felt by only a few people at rest, especially on the upper floors of buildings
III	Felt noticeably indoors, especially on upper floors of buildings
IV	Felt indoors by many people, outdoors by a few; some awaken
V	Felt by nearly everyone; many awaken; dishes and windows break; plaster cracks
VI	Felt by everyone; many frightened and run outdoors; heavy furniture moves
VII	Everyone runs outdoors; slight to moderate damage in ordinary structures
VIII	Considerable damage in ordinary structures; chimneys and monuments fall
IX	Considerable damage in all structures; ground cracks; underground pipes break
X	Most structures destroyed; rails bend; landslides occur; water splashes over banks
XI	Few structures left standing; bridges destroyed; broad fissures in the ground; underground pipes break
XII	Damage total; waves seen on ground surfaces; objects thrown in air

1. What is the approximate location of the earthquake's epicenter?
   (1) 36° N, 90° W (2) 90° N, 36° W (3) 36° N, 90° E (4) 90° N, 36° E

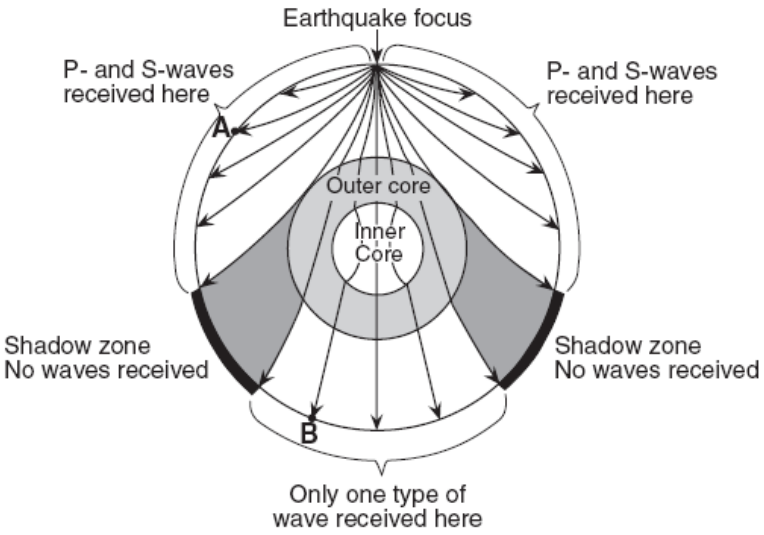
2. Which city would have issued the report: "Heavy furniture moved, everyone felt the earthquake, and many people were frightened and ran outdoors"?
   (1) Cincinnati (2) Pittsburgh (3) Syracuse (4) Boston

3. What was the approximate travel time for the earthquake's P-wave from the epicenter to Syracuse, New York?
   (1) 1 min (2) 5 min (3) 3 min (4) 10 min

4. For which city was the difference in arrival times between P-waves and S-waves the greatest?
   (1) Nashville (2) Pittsburgh (3) Syracuse (4) Boston

5. Which statement best describes the earthquake waves recorded at Louisville?
   (1) S- waves arrived ahead of P-waves.
   (2) Neither S-waves nor P-waves arrived
   (3) S-waves arrived but P-waves did not
   (4) P-waves arrived ahead of S-waves

Base your answers to questions 6 and 7 on the cross-sectional view of Earth below, which shows seismic waves traveling from the focus of an earthquake. Points *A* and *B* are locations on Earth's surface.



6. A seismic station located at point *A* is 5400 kilometers away from the epicenter of the earthquake. If the arrival time for the *P*-wave at point *A* was 2:00 p.m., the arrival time for the *S*-wave at point *A* was approximately

   (1) 1:53 p.m. (3) 2:09 p.m.
   (2) 2:07 p.m. (4) 2:16 p.m.

7. Which statement best explains why only one type of seismic wave was recorded at location *B*?
   (1) *S*-waves cannot travel through the liquid outer core.
   (2) *S*-waves cannot travel through the liquid inner core.
   (3) *P*-waves cannot travel through the solid outer core.
   (4) *P*-waves cannot travel through the solid inner core.

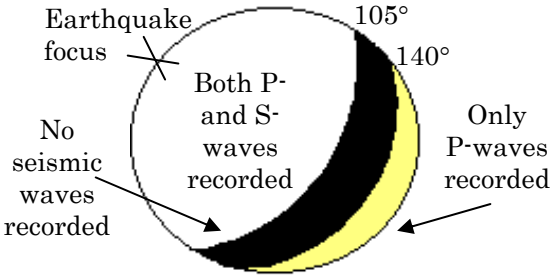
8. Through which materials can P-waves travel?
   (1) Solid rock, only
   (2) Solid rock, magma, water, and natural gas
   (3) Magma, water, and natural gas only
   (4) Magma and water, only

9. Earthquake S-waves do not travel through the Earth's
   (1) crust (2) moho (3) mantle (4) core

10. Which statement about earthquake waves best supports the inference that the Earth's outer core is liquid?
   (1) The velocity of earthquake waves increases as the distance from an epicenter increases.
   (2) The difference in arrival times for compressional and shear waves increases as the distance from an epicenter increases.
   (3) Compressional waves travel faster than shear waves.
   (4) Shear waves travel only through solids.

11. An earthquake recorded by seismic stations around the world created the pattern of seismic wave recordings shown in the diagram below. Which statement best explains this pattern of wave recordings?

   (1) Some seismic waves cannot travel through oceans to reach every location on Earth.
   (2) S-waves are too weak to travel very far from the earthquake focus.
   (3) Mountain ranges and tectonic plate boundaries absorb or bend seismic waves
   (4) Layers with different properties inside Earth absorb or bend seismic waves.



12. The theory that the outer core of the Earth is composed of liquid material is best supported by
   (1) seismic studies which indicate that shear waves do not pass through the outer core
   (2) seismic studies which show that compressional waves can pass through the outer core
   (3) density studies which show that the outer core is slightly more dense than the inner core
   (4) gravity studies which indicate that gravitational strength is greatest within the core

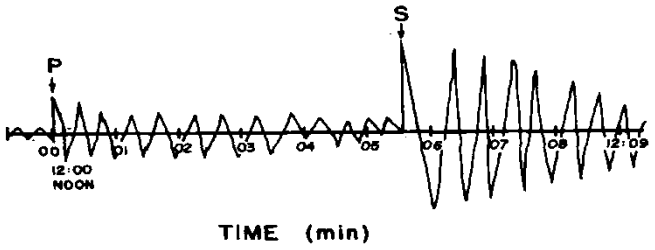
13. What is the total distance that a P-wave will travel in 7 minutes and 20 seconds?
   (1) 2,000 km (2) 5,800 km (3) 4,200 km (4) 7,200 km

14. In 8 minutes, an earthquake P-wave travels a total distance of
   (1) 2,100 km (2) 4,700 km (3) 6,600 km (4) 11,300 km

15. Approximately how far away from the receiving station is the epicenter of an earthquake if the difference in arrival times of P– and S– waves at the station is 6 minutes and 30 seconds?
(1) 3,000 km (2) 5,000 km (3) 6,300 km (4) 8,000 km

16. A seismograph indicates the difference between the arrival of S-waves and P-waves to be 4 minutes. The distance of the seismograph station from the earthquake's epicenter is about
(1) 1,000 km (2) 1,500 km (3) 2,000 km (4) 2,500 km

17. The seismograph to the right shows the arrival times of P-wave and S-waves from a single earthquake. How far from the earthquake epicenter was the station that recorded this seismogram?
(1) 1.5×10^3 km (3) 7.5×10^3 km
(2) 4.0×10^3 km (4) 2.6×10^3 km



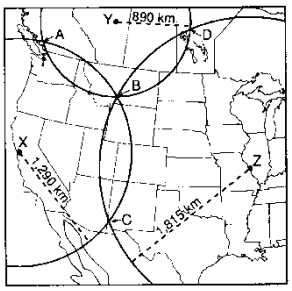
18. The epicenter of an earthquake is located near Massena, New York. The greatest difference in arrival times of the P- and S-waves for this earthquake would be recorded in
(1) Plattsburg, New York (3) Albany, New York
(2) Binghamton, New York (4) Utica, New York

19. At a seismograph recording station, the difference between the arrival times of an earthquake's compression wave (P-wave) and its shear wave (S-wave) is 8 minutes 20 seconds. How far from the station is the epicenter?
(1) 2,400 km (2) 4,500 km (3) 5,000 km (4) 6,800 km

20. What is the approximate difference in arrival times of the P-waves and the S-waves at a seismographic station that is 3,000 kilometers from an earthquake epicenter?
(1) 2 min 15 sec (2) 3 min 40 sec (3) 4 min 30 sec (4) 5 min 40 sec

21. The circles on the map to the right show the distances from three seismic stations, X, Y and Z, to the epicenter of an earthquake.

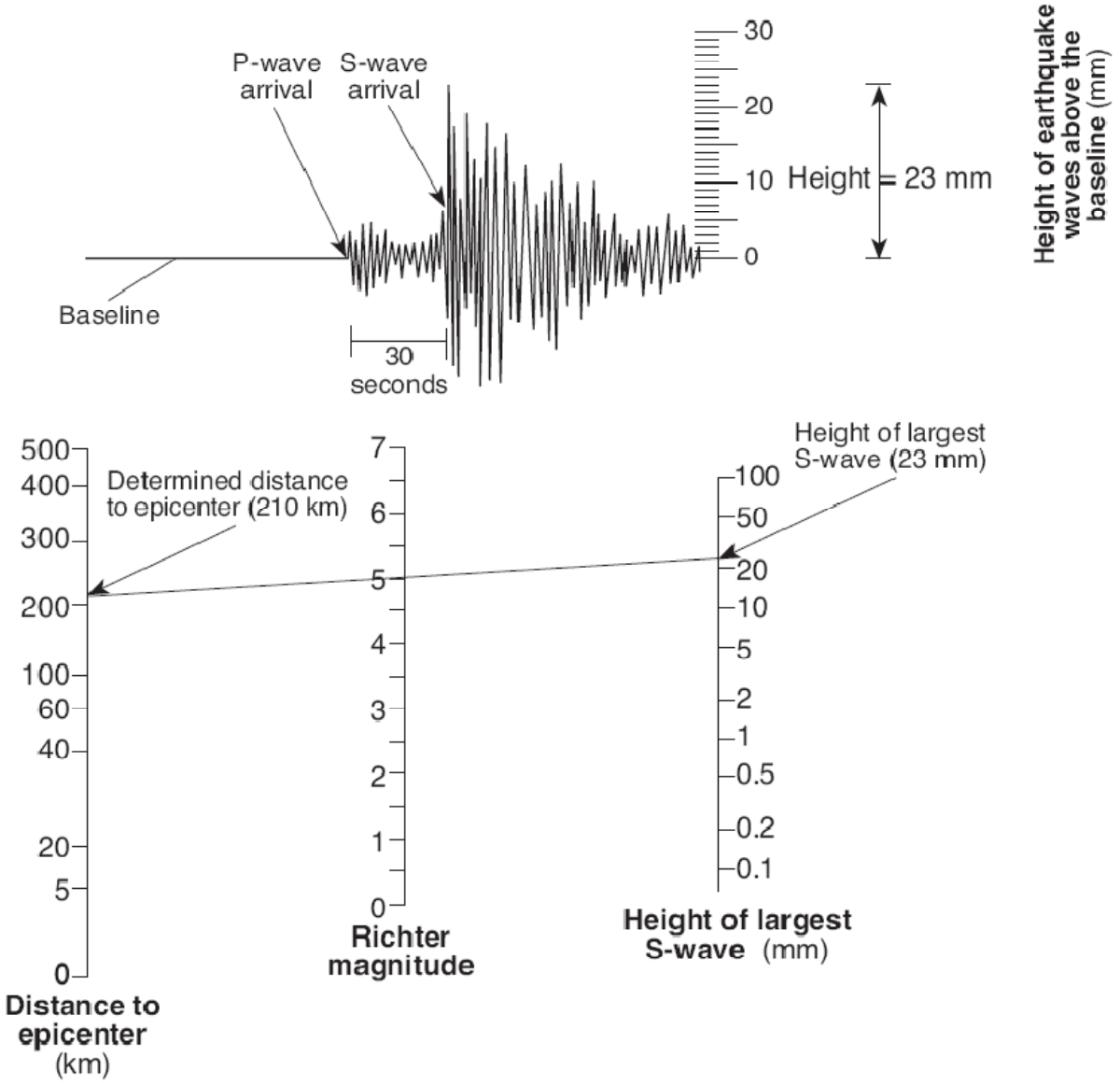
Which location is closest to the earthquake epicenter?
(1) A (2) B (3) C (4) D



22. The *S*-waves from an earthquake that travel toward Earth's center will
(1) be deflected by Earth's magnetic field
(2) be totally reflected off the crust-mantle interface
(3) be absorbed by the liquid outer core
(4) reach the other side of Earth faster than those that travel around Earth in the crust

Base your answers to questions 23 through 25 on the example of a seismogram and set of instructions for determining the Richter magnitude of an earthquake below. The example shows the Richter magnitude of an earthquake 210 kilometers from a seismic station.

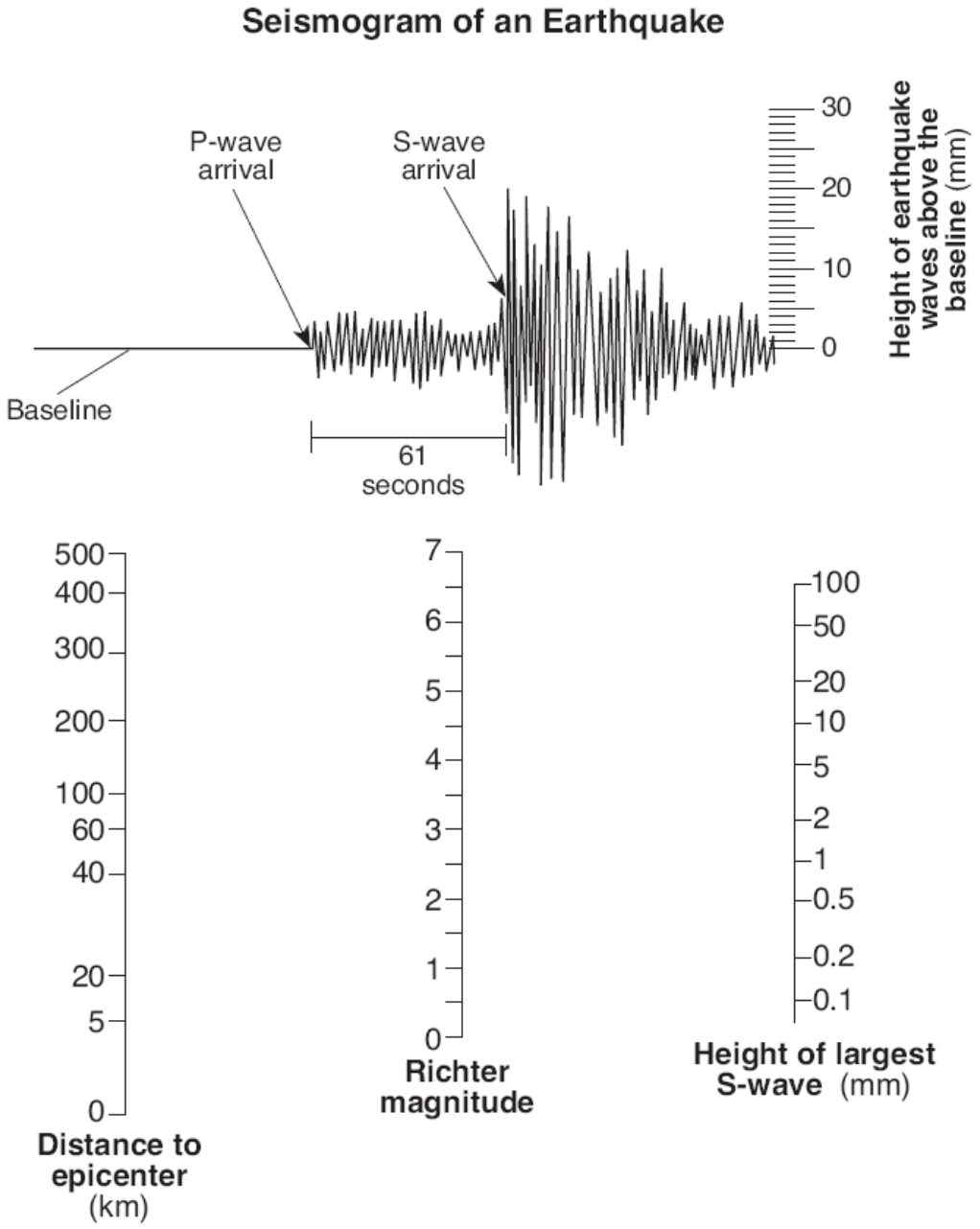
Example of a Seismogram of an Earthquake



Instructions for determining Richter magnitude:

- Determine the distance to the epicenter of the earthquake. (The distance in the example is 210 kilometers.)
- Measure the maximum wave height of the S-wave recorded on the seismogram. (The height in the example is 23 millimeters.)
- Place a straightedge between the distance to the epicenter (210 kilometers) and the height of the largest S-wave (23 millimeters) on the appropriate scales. Draw a line connecting these two points.
- The magnitude of the earthquake is determined by where the line intersects the Richter magnitude scale. (The magnitude of this example is 5.0.)

23. Using the set of instructions on page 88 and the seismogram and scales below, determine the Richter magnitude of an earthquake that was located 500 kilometers from this seismic station. _____



24 Identify the information shown on the seismogram that was used to determine that the distance to the epicenter was 500 kilometers.

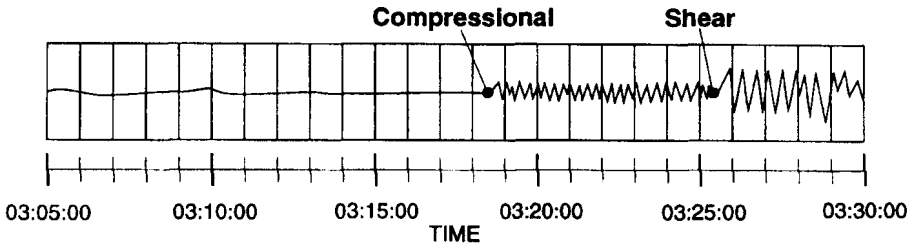
_____

_____

25 How long did it take the first S-wave to travel 500 kilometers to reach this seismic station?

_____ min _____ sec

26. A seismogram recorded at a seismic station is shown below.



Which information can be determined by using this seismogram?
(1) the depth of the earthquake's focus
(2) the direction to the earthquake's focus
(3) the location of the earthquake's epicenter
(4) the distance to the earthquake's epicenter

27. Which generalization about earthquake S-waves and P-waves is correct?
(1) When the P-waves and S-waves are near the epicenter, they both travel at the same speed.
(2) The velocity of P-waves and S-waves is constant, regardless of the distance traveled.
(3) P-waves always travel faster than S-waves regardless of the distance traveled.
(4) S-waves always travel about twice as fast as P-waves

28. An earthquake's *P*-wave arrived at a seismograph station at 02 hours 40 minutes 00 seconds. The earthquake's *S*-wave arrived at the same station 2 minutes later. What is the approximate distance from the seismograph station to the epicenter of the earthquake?
(1) 1,100 km (2) 2,400 km (3) 3,100 km (4) 4,000 km

29. An earthquake's magnitude can be determined by
(1) analyzing the seismic waves recorded by a seismograph
(2) calculating the depth of the earthquake faulting
(3) calculating the time the earthquake occurred
(4) comparing the speed of P-waves and S-waves

30. The seismogram to the right shows P-wave and S-wave arrival times at a seismic station following an earthquake. The distance from this seismic station to the epicenter of the earthquake is approximately
(1) 1,600 km (3) 4,400 km
(2) 3,200 km (4) 5,600 km

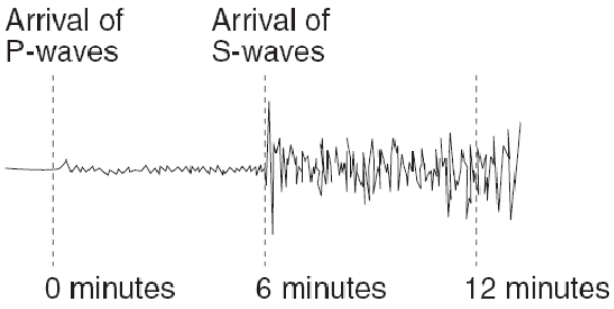


Plate Tectonics

Continental Drift: _____

_____

_____

_____

_____

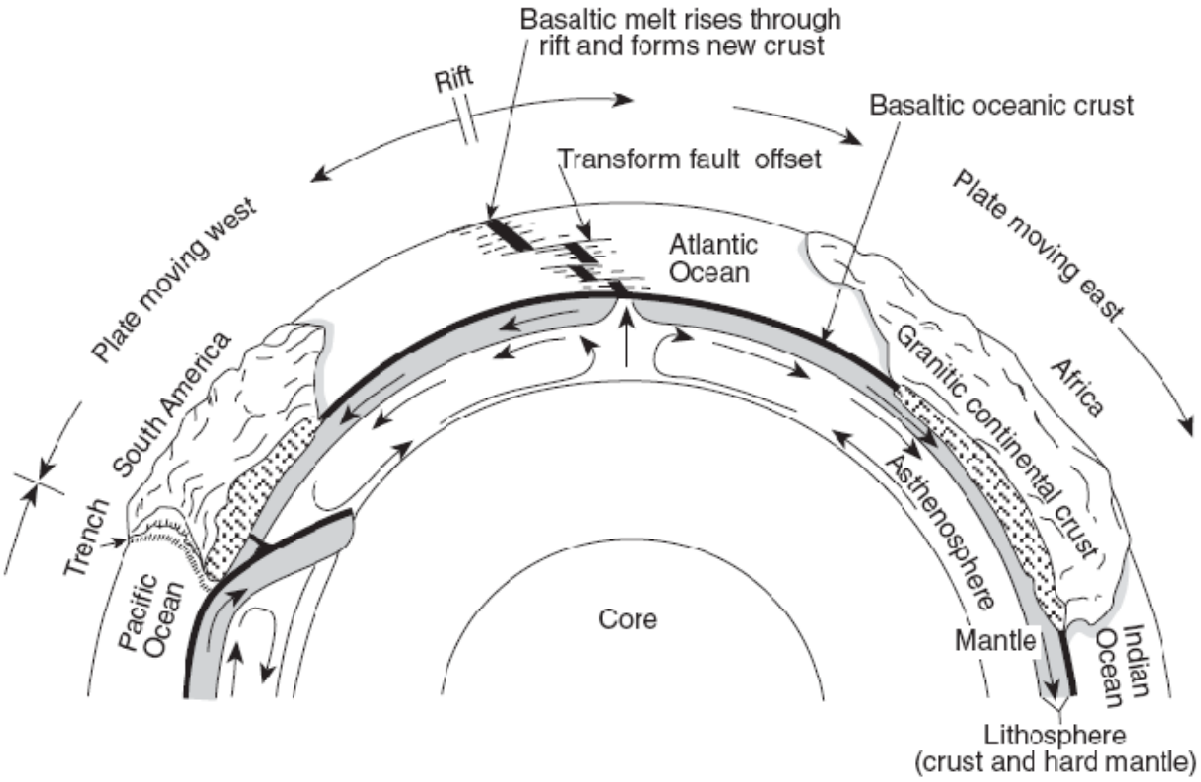
_____

Pangea _____

_____

Evidence for Continental Drift

Movement of Plates



(Not drawn to scale)

Convection currents _____

Rising currents _____

_____

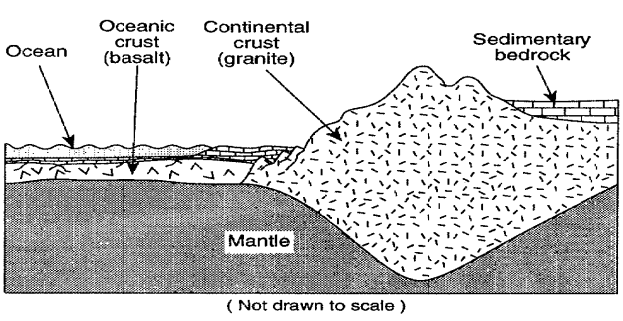
_____

Falling currents _____

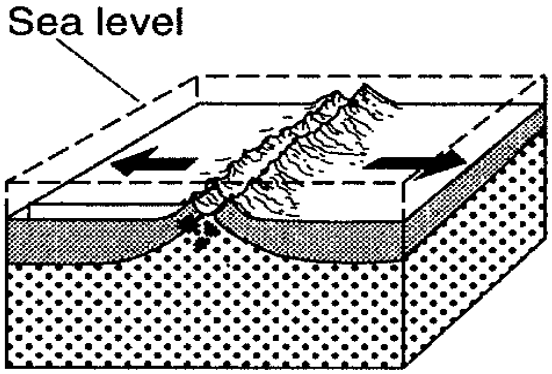
_____

_____

	Continental Crust	Oceanic Crust
Composition		
Density		
Thickness		

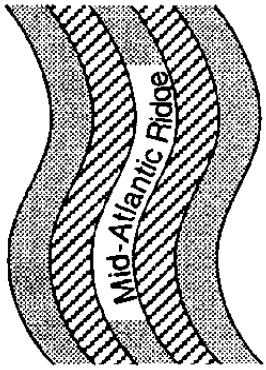


Divergent Boundaries:



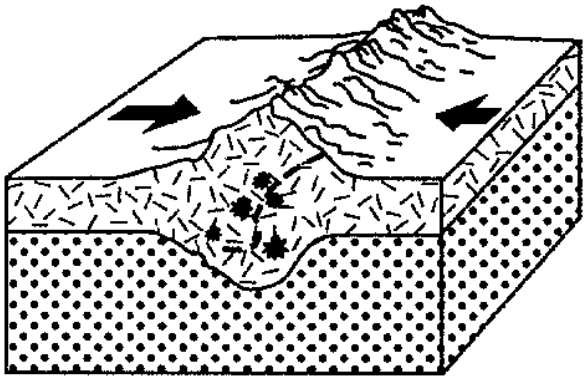
Normal Polarity

Reversed Polarity



Evidence that pates are moving apart:

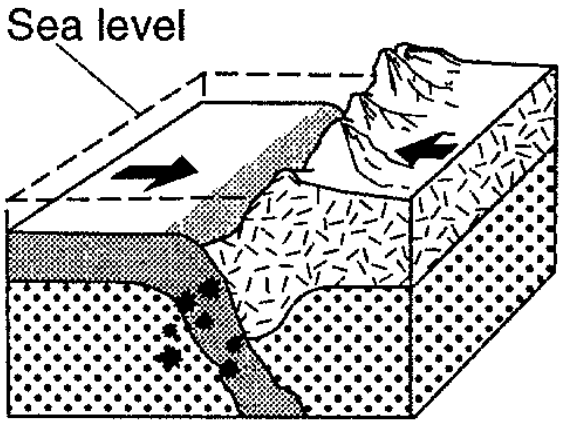
Convergent boundaries: _____



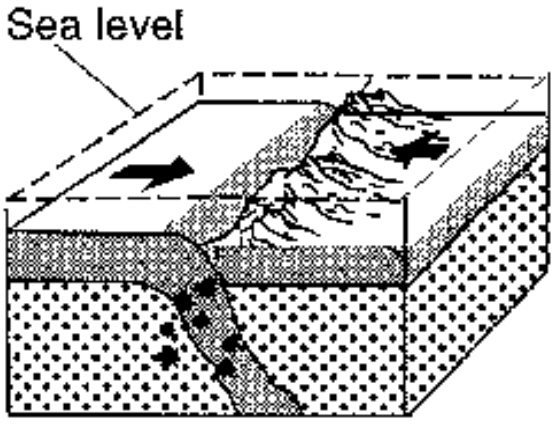
Collision Boundary

Subduction Boundaries:

Ocean / Continental Plates

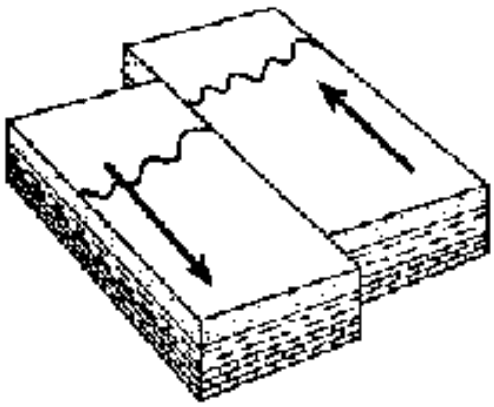


Ocean / Ocean Plates



Transform boundaries: _____

_____



MORE Evidence for crustal movement:

Bench Marks _____

_____

_____

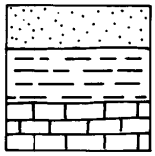
Uplift of fossils _____

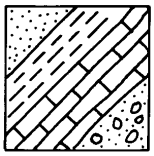
_____

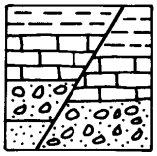
Subsidence of fossils _____

_____

Looking at Rock Strata







_____ _____ _____ _____

Hot spot: _____

_____

_____

Earth Science Reference Tables Practice page 5
"Tectonic Plates"

1. Using a yellow highlighter, highlight the **NAMES** of each of the following . . .
   - hot spots, ocean ridges, and trenches
2. Using a red color pencil, color each of the hot spot  locations.
3. Fill in the names of the Hot Spots at each of the following locations.

Location	Name of Hot spot	Location	Name of Hot spot
United States		East Pacific Ridge	
Pacific Plate		Indian-Australian Plate	
Nazca Plate		East of Mid-Atlantic Ridge	
Eurasian Plate		Between African and Antarctic Plate	
African Plate			

4. Name the two plates located on either side of each of the following trenches.

Trench	Plate name	Plate name
Aleution Trench		
Mariana Trench		
Tonga Trench		
Peru-Chile Trench		

5. Name the two plates located on either side of each of the following ridges.

Ridge	Plate name	Plate name
East Pacific Ridge		
Mid -Atlantic Ridge		
Southwest Indian Ridge		
Southeast Indian Ridge		
Mid-Indian Ridge		

6. In the boxed below, draw the symbols for each of the following boundaries:

Convergent Plate Boundary	Complex or Uncertain Boundary
Divergent Plate Boundary	Transform Plate Boundary

7. Draw the symbol for the Mid-Ocean Ridge in the box to the right.

7. What do the arrows on the map indicate? _____

8. Look at the arrows along any of the trenches, on the two adjoining plates. Are the plates moving toward each other or away from each other? _____

9. What kind of boundary is located at a trench? _____

10. Look at the arrows along any of the ridges, on the two adjoining plates. Are the plates moving toward each other or away from each other? _____

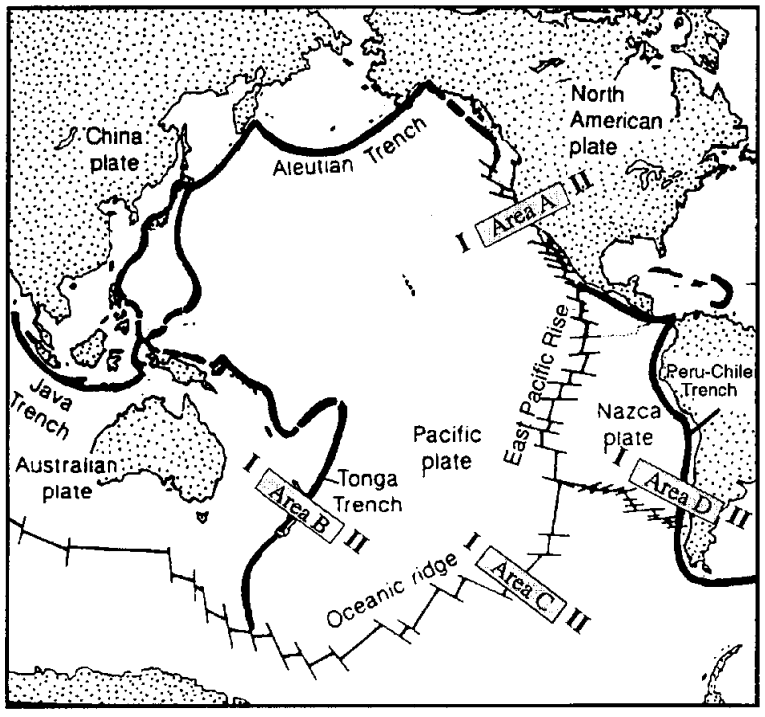
11. What kind of boundary is located at a ridge? _____

12. Find the San Andres' Fault. What type of boundary is this? _____

13. In the table below, state the direction of movement of the plates.

Name of Plate	Direction	Name of Plate	Direction
South American Plate	SW	Antarctic Plate - below Pacific Plate	
African Plate		Antarctic Plate - below African Plate	
Pacific Plate		North American Plate – west coast	
Nazca Plate		North American Plate – near Iceland	
Eurasian Plate		Indian - Australian Plate	

The map shows mid-ocean ridges and trenches in the Pacific Ocean. Specific areas *A*, *B*, *C*, and *D* are indicated by shaded rectangles.



14. Draw two arrows at each Area (A, B and C) to illustrate the movement of the plates.

15. What type of boundary is located at Area A? _____

16. What type of boundary is located at Area B? _____

17. What type of boundary is located at Area C? _____

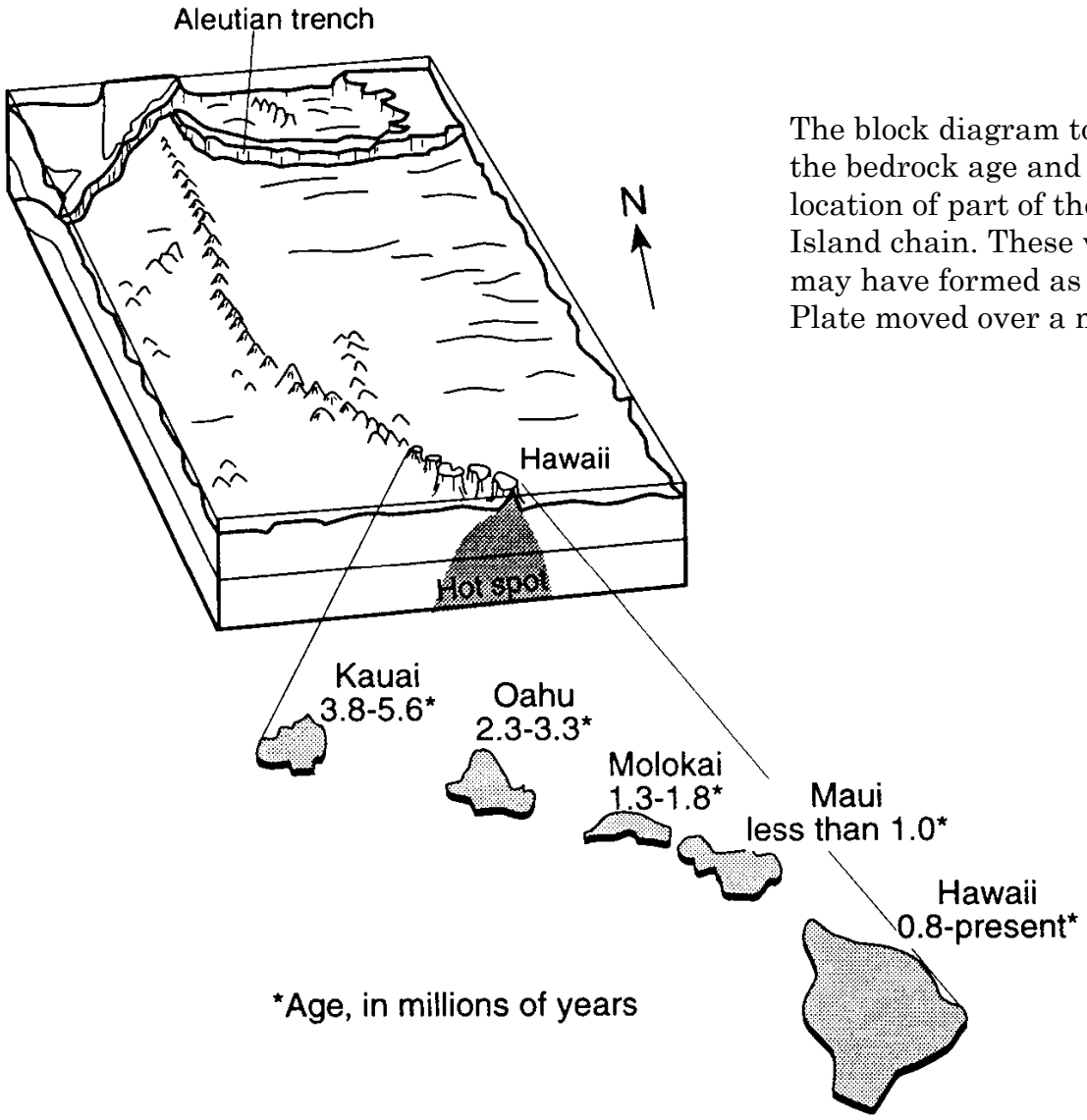
18. Movement of the crustal plates is most likely caused by

(1) the revolution of the Earth

(2) the erosion of Earth's crust

(3) shifting of Earth's magnetic poles

(4) convection currents in Earth's mantle



The block diagram to the left shows the bedrock age and the present location of part of the Hawaiian Island chain. These volcanic islands may have formed as the Pacific Plate moved over a mantle hot spot.

20. Which island is the oldest? _____
21. Which island is the youngest? _____
22. Which plate is the Hawaiian Hot Spot located? _____
23. In which direction was the plate probably moving toward? _____
24. Make an inference on why the island of Hawaii is larger than any of the other islands.

_____

_____

25. Another island is forming in the same area. Looking at the chain of existing islands, infer where this new island is forming. _____

26 In the last 100 years, most of the world's earthquakes have taken place in a region along the rim of the Pacific ocean known as the _____


Earth's Crustal Plate Boundaries
Divergent boundary
Transform Boundary
where two plates
where two plates
where two plates
formation of
formation of
an example is
an example is
three types are
where two oceanic plates collide
where oceanic and continental plates collide
this occurs
this occurs
this occurs
with subduction
with no subduction
with subduction
formation of
formation of
formation of
an example is
an example is
an example is

Regents Questions:

1. The best evidence of crustal movement would be provided by
   (1) dinosaur tracks found in the surface bedrock
   (2) marine fossils found on a mountaintop
   (3) weathered bedrock found at the bottom of a cliff
   (4) ripple marks found in sandy sediment

2. Fossils of marine life can be found at locations higher than 200 meters above sea level in New York State. Which statement best explains this fact?
   (1) Much of New York State was once below sea level and has since been uplifted.
   (2) Much of New York State was once above sea level and has since subsided.
   (3) Sea level was once more than 200 meters lower than it is today.
   (4) Sea level was once more than 200 meters higher than it is today.

3. Shallow-water fossils are found in rock layers that are deep beneath the ocean floor. This suggests that
   (1) shallow-water organisms always migrate to the deeper waters to die
   (2) parts of the ocean floor have been uplifted
   (3) parts of the ocean floor have subsided
   (4) the surface water cooled off, killing the organisms

4. The theory of continental drift does not explain the
   (1) matching of rock features on continents thousands of kilometers apart
   (2) melting of glacial ice at the close of the Pleistocene Epic
   (3) apparent fitting together of many continental boundaries
   (4) fossils of tropical plants in Antarctica

5. Igneous rocks on the ocean floor that have an alternating pattern of magnetic orientation provide evidence that
   (1) mountains are rising
   (2) the seafloor is spreading
   (3) the Earth was struck by meteorites
   (4) ocean tides are cyclic

6. Two samples of ocean floor basaltic bedrock are found at equal distances from, and on opposite sides of, a mid-ocean ridge. The best evidence that both samples were formed at the ridge during the same time period would be that both samples also
   (1) have the same density
   (2) contain different crystal sizes
   (3) are located at different depths below sea level
   (4) have the same magnetic field orientation

7. The best evidence of crustal uplift is provided by
   (1) marine fossils found in the bedrock of some mountaintops
   (2) shallow-water marine fossils found in deep ocean water
   (3) horizontal sedimentary layers
   (4) thick layers of sediment on the ocean floor

8. Evidence of crustal subsidence (sinking) is provided by
   (1) zones of igneous activity at mid-ocean ridges
   (2) heat-flow measurements on coastal plains
   (3) marine fossils on mountaintops
   (4) shallow-water fossils beneath the deep ocean

9. A sandstone layer is tilted at a steep angle. What probably caused this tilting?
   (1) nearly all sandstone layers are formed from wind deposited sands
   (2) this sandstone layer has changed position due to crustal movement
   (3) this sandstone layer has recrystallized due to contact metamorphism
   (4) the sediments that formed this sandstone layer were originally deposited at a steep angle

10. As evidence accumulates the support for the theory that the present continents were at one time a single, large landmass
   (1) increases (2) deceases (3) remains the same

11. Which evidence suggests that sections of the Earth's crust have been uplifted in the past?
   (1) Fossils of organisms that lived in shallow water are found at great ocean depths.
   (2) Fossils of organisms that lived in the oceans are found in rocks above sea level.
   (3) Sediments that were deposited in shallow water are found in great thicknesses.
   (4) Large ocean basins containing accumulations of sediments show signs of subsidence (sinking)

12. Which statement best supports the theory that all the continents were once a single landmass?
   (1) Rocks of the ocean ridges are older than those of the adjacent sea floor
   (2) Rock and fossil correlation can be made where the continents appear to fit together.
   (3) Marine fossils can be found at high elevations above sea level on all continents.
   (4) Great thickness of shallow water sediments are found at interior locations on some continents.

13. For the last 200 million years, continents on opposite sides of the Atlantic ocean have generally
   (1) been drifting apart
   (2) been drifting closer together
   (3) remained the same distance apart

14. Which statement best supports the theory of continental drift?
   (1) Basaltic rock is found to be progressively younger at increasing distances from a mid-ocean ridge.
   (2) Marine fossils are often found in deep-well drill cores.
   (3) The present continents appear to fit together as pieces of a larger landmass
   (4) Areas of shallow-water seas tend to accumulate sediment, which gradually sinks.

15. Which geologic period were the continents all part of one landmass, with North America and South America joined to Africa?
(1) Tertiary (2) Cretaceous (3) Triassic (4) Carboniferous

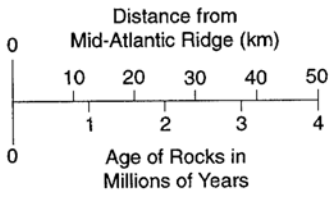
16. What is the direction of crustal movement of the Indian-Australian plate?
(1) northward (2) southward (3) northwestward (4) southwestward

17. Igneous materials found along oceanic ridges contain magnetic iron particles that show reversal of magnetic orientation. This is evidence that
(1) volcanic activity has occurred constantly throughout history
(2) the Earth's magnetic poles have exchanged their positions
(3) igneous materials are always formed beneath oceans
(4) the Earth's crust does not move

18. Which is the best evidence supporting the concept of ocean floor spreading?
(1) Earthquakes occur at greater depths beneath continents than beneath oceans.
(2) Sandstones and limestones can be found both in North America and Europe.
(3) Volcanoes appear at random within the oceanic crust.
(4) Igneous rocks along the mid-oceanic ridges are younger than those farther from the ridges.

19. Igneous rocks on the ocean floor that have an alternating pattern of magnetic orientation provide evidence that
(1) mountains are rising
(2) the seafloor is spreading
(3) Earth was struck by meteorites
(4) ocean tides are cyclic

20. The scale to the right shows the age of rocks in relation to their distance from the Mid-Atlantic Ridge. Some igneous rocks that originally formed at the Mid-Atlantic Ridge are now 37 kilometers from the ridge.

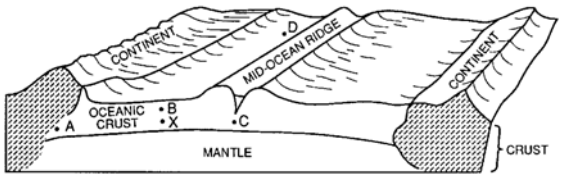


Approximately how long ago did these rocks form?
(1) 1.8 million years ago
(2) 2.0 million years ago
(3) 3.0 million years ago
(4) 45.0 million years ago

21. Which is the best evidence of crustal movement?
(1) molten rock in the Earth's outer core
(2) residual sediments on top of bedrock
(3) tilted sedimentary rock layers
(4) marine fossils found below sea level

22. Folded sedimentary rock layers are usually caused by
(1) Deposition of sediments in folded layers
(2) Differences in sediment density during deposition
(3) A rise in sea level after deposition
(4) Crustal movement occurring after deposition

23. The diagram to the right represents a cross of a section portion of the Earth's crust and mantle. Letters A, B, C, D and X identify locations within the crust.
The age of oceanic crust increases along a line between X and location
(1) A (2) B (3) C (4) D

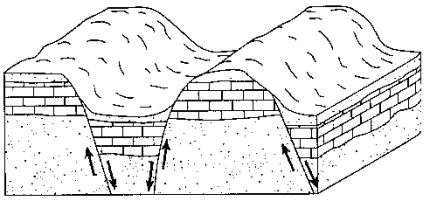


24. The diagrams below show cross sections of exposed bedrock. Which cross section shows the least evidence of crustal movement?

(1) (2) (3) (4)

25. Compared to the velocity of an earthquake's P-waves, the velocity of the S-waves in the same material is
(1) less (2) greater (3) the same

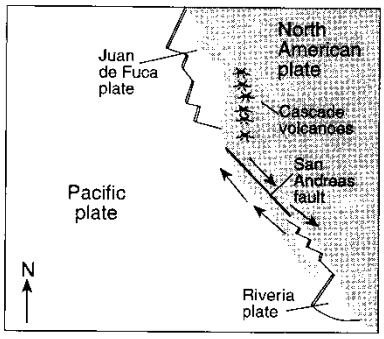
26. The diagram to the right shows a portion of the Earth's crust. The movements indicated by the arrows represent the process of
(1) volcanism (3) metamorphism
(2) folding (4) faulting



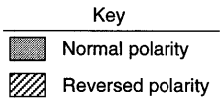
27. Which event provides direct evidence of crustal movement?
(1) the erosion of the outside of a river curve
(2) the deposition of sediments in the ocean
(3) the displacement of rock strata during an earthquake
(4) the weathering of rock to form a residual soil

28. Which of the following locations is the site of a convergent plate boundary?
(1) Mid-Atlantic ridge (3) Atlantic-Indian ridge
(2) Pacific/North American plate boundary (4) Aleutian Trench

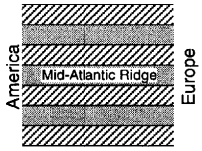
29. The map to the right shows continental and oceanic crustal plates along the west coast of North America. Which conclusion is best supported by the map?
(1) The boundary of the Pacific plate has very few faults.
(2) The Pacific plate has stopped moving
(3) The West Coast of North America is composed of the oldest rock on the continent
(4) The West Coast of North America is a zone of frequent crustal activity.



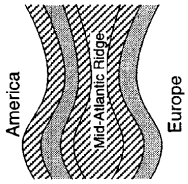
30. Which map best represents the general pattern of magnetism in the oceanic bedrock near the mid-Atlantic Ridge.



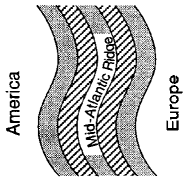
(1)



(2)



(3)



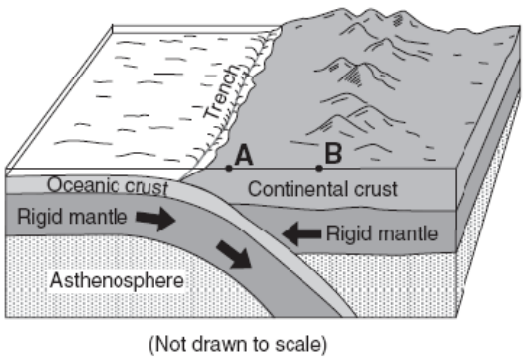
(4)

31. Where have earthquakes occurred most frequently during the last one hundred years?
(1) in the polar regions
(2) along the Pacific Ocean coastlines
(3) in the interior of continental areas
(4) along the Atlantic Ocean coastlines

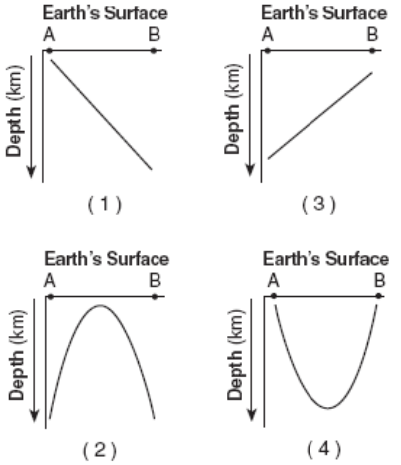
32. Where are earthquakes most likely to take place?
(1) along the core-mantle interface
(2) where the composition of the Earth tends to be uniform
(3) near the Earth's Equator
(4) near a fault zone

33. Which best describes a major characteristic of both volcanoes and earthquakes?
(1) They are centered at the poles.
(2) They are located in the same geographic areas.
(3) They are related to the formation of glaciers.
(4) They are restricted to the Southern Hemisphere

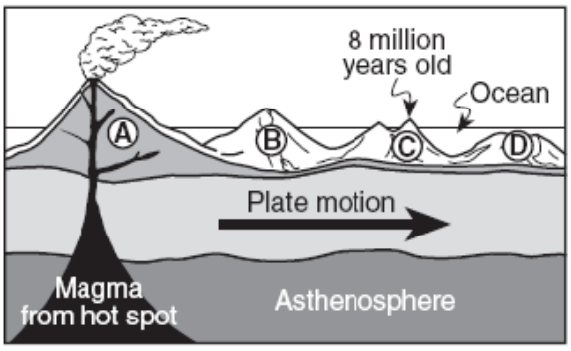
34. The block diagram below shows a tectonic plate boundary. Points *A* and *B* represent locations on Earth's surface. Which graph best shows the depths of most major earthquakes whose epicenters lie between *A* and *B*?



(Not drawn to scale)



35. The cross section below shows the direction of movement of an oceanic plate over a mantle hot spot, resulting in the formation of a chain of volcanoes labeled *A*, *B*, *C*, and *D*. The geologic age of volcano *C* is shown. What are the most likely geologic ages of volcanoes *B* and *D*?



(1) *B* is 5 million years old and *D* is 12 million years old.
(2) *B* is 2 million years old and *D* is 6 million years old.
(3) *B* is 9 million years old and *D* is 9 million years old.
(4) *B* is 10 million years old and *D* is 4 million years old.

Base your answers to questions 36 through 39 on the information below and on your knowledge of Earth science.

In the 1930s, most scientists believed that Earth's crust and interior were solid and motionless. A small group of scientists were talking about "continental drift," which is the idea that Earth's crust is not stationary, but is constantly shifting and moving. From seismic data, geophysical evidence, and laboratory experiments, scientists now generally agree that lithospheric plates move at the surface. Both Earth's surface and interior are in motion. Solid rock in the mantle can be softened and shaped when subjected to the heat and pressure within Earth's interior over millions of years.

Subduction processes are believed by many scientists to be the driving force of plate tectonics. At present, this theory cannot be directly observed and confirmed. The lithospheric plates have moved in the past and are still moving today. The details of why and how they move will continue to challenge scientists.

36. Earth's crust is described as "constantly shifting and moving." Give two examples of geologic evidence that supports the conclusion that continents have drifted apart.

_____

_____

_____

_____

37. The information given suggests that "subduction processes are the driving force of plate tectonics." Identify a specific location of a subduction zone on Earth.

_____

_____

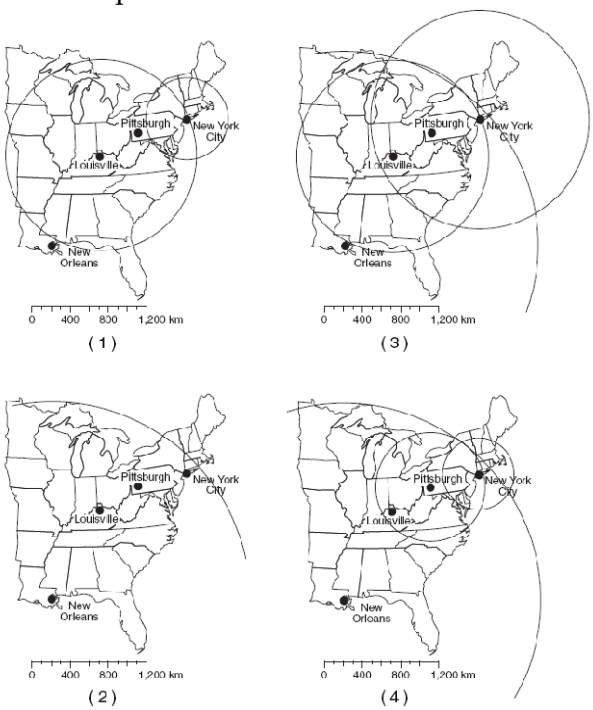
38. According to the Earth Science Reference Tables, at what inferred depth is mantle rock partially melted and slowly moving below the lithospheric plates?

_____

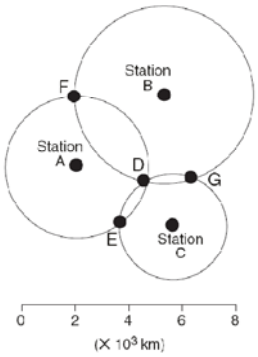
Base your answers to questions 39 and 40 on the map below. Seismic stations are located at the four cities shown on the map. Letter *X* represents the epicenter of an earthquake determined from seismic waves recorded at all four cities.

39. At which city is there a difference of approximately 3 minutes and 20 seconds between the arrival times of the *P* waves and the *S* waves?
(1) New Orleans (3) Pittsburgh
(2) Louisville (4) New York City

40. Which map correctly shows how the location of the epicenter was determined?



Base your answers to questions 41 and 42 on the diagram below, which represents seismic stations *A*, *B*, and *C*. The distance from each station to an earthquake's epicenter is plotted.



41. The *P* wave of an earthquake originating 2,600 kilometers from seismic station *A* arrived at 5:24:45 a.m. What was the arrival time of the *S* wave from the same earthquake?
(1) 1:24:45 a.m. (3) 5:28:45 a.m.
(2) 5:21:05 a.m. (4) 9:24:05 a.m.

42. The epicenter is closest to point
(1) *D* (2) *F* (3) *E* (4) *G*

43. Approximately how long does an earthquake *P* wave take to travel the first 6500 kilometers after the earthquake occurs?
(1) 6.5 min (2) 8.0 min (3) 10.0 min (4) 18.5 min